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ABSTRACT

A nuclear technology college course for engineering students is outlined and described. The course begins with an historical account of the scientific discoveries leading up to the uranium experiments of Hahn and Strassman in Germany and the subsequent explanation of nuclear fission by Meitner and Frisch. The technological achievements of the Manhattan Project are presented. Students learn about the atomic bombings of Hiroshima and Nagasaki by reading John Hersey's book "Hiroshima" and viewing the film "Hiroshima and Nagasaki: The Harvest of Nuclear War." The course then covers the "Atoms for Peace" program that was initiated by President Eisenhower in 1953. Particular emphasis is placed on the technology of nuclear power plants such as pressurized water reactors and the liquid metal fast breeder reactor. Pros and cons of nuclear power are examined and nuclear weapons proliferation is discussed. The final part of the course is concerned with the technology of modern nuclear weapons and delivery systems, including thermonuclear devices and radiological weapons. Required readings are listed; bibliographic information on the films and videotapes used in the course is provided. (RM)

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A NUCLEAR TECH COURSE -
NUCLEAR TECHNOLOGY IN WAR AND PEACE:
A STUDY OF ISSUES AND CHOICES

J. Richard Shanebrook
Union College
Schenectady, New York

February 1985

1. Course Title and Catalog Description for Engineering Liberal Learning 49

ELL 49. "Nuclear Technology in War and Peace: A Study of Issues and Choices". Explores the technology of nuclear weapons and nuclear energy for electric power generation. Associated problems of nuclear weapons proliferation and technological alternatives are considered.

2. Responsible Professor

J. Richard Shanebrook
Mechanical Engineering Department

3. When Taught and Enrollments

Spring Term, 1984, to 17 students
Fall Term, 1984, to 23 students

4. Prerequisites

None

5. Course Description

The course begins with an historical account of the scientific discoveries leading up to the uranium experiments of Hahn and Strassman in Germany and the subsequent explanation of nuclear fission by Meitner and Frisch. Following this, the technological achievements of the Manhattan Project are presented including techniques of uranium enrichment, extraction of plutonium from irradiated reactor fuel rods, and the design of "gun barrel" and implosion types of nuclear weapons. This discussion concludes with a viewing of the award-winning film, "The Day After Trinity: J. Robert Oppenheimer and the Atomic Bomb."

Covered next are the atomic bombings of Hiroshima and Nagasaki with a class assignment to read John Hersey's book, Hiroshima. Included in this topic is a viewing of the film, "Hiroshima and Nagasaki: The Harvest of Nuclear War." This film was produced in Japan (March 1982) and was planned by the cities of Hiroshima and Nagasaki. It features film footage recorded by Japanese photographers shortly after the nuclear explosions at these two cities in August of

1945. Interviews with survivors of the bombings are also presented in order to accurately describe the horrible consequences of using nuclear weapons against human beings. From a pedagogical standpoint, the reading of Hiroshima and the viewing of this film proved to be very beneficial to the course as a whole since they both portrayed actual events and consequences of nuclear warfare.

The course then covers the 'Atoms for Peace' program that was initiated by President Eisenhower in 1953. Particular emphasis is placed on the technology of nuclear power plants such as pressurized water reactors and the liquid metal fast breeder reactor. This includes the reading of one pro-nuclear power book by Fred and Geoffrey Hoyle, Commonsense in Nuclear Energy, and one anti-nuclear power book by Helen Caldicott, Nuclear Madness. The discussion on breeder reactors includes arguments for and against this technology which leads naturally to a discussion of nuclear weapons proliferation. The latter topic is enchanced by a reading of John McPhee's, The Curve of Binding Energy.

The final portion of the course is concerned with the technology of modern nuclear weapons and delivery systems. The weapons discussion includes thermonuclear devices (fission-fusion-fission) as well as radiological weapons such as the cobalt bomb. The discussion of waging modern nuclear war is based on the book, The Counterforce Syndrome, by Robert C. Aldridge and includes the following technological systems:

- Anti-satellite weapons
- Counterforce missiles
- Anti-submarine weapons
- Anti-ballistic missile weapons
- Command, control, and communication networks

The above discussion is a brief outline of the major topics of this course. Several other topics are interwoven throughout the course such as "peace through strength" arguments in favor of increased armaments, civil defense measures, and technological alternatives to nuclear power.

6. Course Outline for ELL 49

I. Origin of Energy, Matter, and Life in Our Universe

- A. The Big Bang Theory
- B. Hydrogen and uranium formation (supernovae explosions)
- C. Life on earth
- D. Deoxyribonucleic acid

II. The Atomic Structure of Matter

- A. Natural and man-made elements
- B. Radioactivity
- C. Discoveries of Roentgen, Becquerel and Curie
- D. Rutherford's Theory
- E. Isotopes
- F. The neutron (James Chadwick)
- G. The equivalence of mass and energy (Albert Einstein)

III. Nuclear Fission

- A. The experiments of Hahn and Strassman in Germany, as explained by Meitner and Frisch
- B. Fissionable materials (isotopes)
- C. The discovery of plutonium

IV. The Atomic Bomb

- A. Szilard, Wigner, and Einstein foresee military applications of nuclear fission
- B. The Manhattan Project: Profiles of Robert Oppenheimer and Edward Teller
- C. The decision to drop the bomb on Japan
  1. The Franck Report of June 11, 1945
  2. The Chicago poll of scientists (June, 1945)
- D. The Trinity Test of a plutonium weapon
- E. Hiroshima
- F. Nagasaki

V. The Hydrogen Bomb

- A. Edward Teller and the "Super Bomb"
- B. Claus Fuchs, the Russian Agent
- C. Opposition to building the hydrogen bomb
- D. The decision to build the first thermonuclear weapon

VI. Nuclear Energy for Electric Power Production

A. The Atomic Energy Act of 1946
B. Arguments in favor of nuclear power plants
C. Arguments opposed to nuclear power plants
D. The accident at Three Mile Island
E. Current status of power reactors in America and the world

VII. The Breeder Reactor

A. Supplies of Uranium-235
B. Elements of a plutonium society
C. Arguments in favor of breeder reactors
D. Arguments opposed to breeder reactors
E. Current status of breeder reactors in America and the world

VIII. Energy Choices

A The end of the fossil fuel era on earth
B. The need for energy in a technological society
C. The effect of population growth on energy demand
D. Nuclear energy vs. solar energy: Which path to take?
E. Energy for Third World nations
F. The relatonship between energy needs and armed conflict (The Carter Doctrine)

IX. Nuclear Weapon Systems Today

A. Nuclear arsenals in America and Russia
B Delivery systems from land, sea, and air
C. Presidential Directive No. 59
D. Counterforce weapons (MX, Trident, Cruise Missiles)
E. Command, control, and communication systems for a first-strike nuclear attack

X. Survival in a Nuclear Age

A. Treaties to prevent the spread of nuclear weapons (Antarctic, Outer Space, Latin America, Non-Proliferation, Seabed)
B. Treaties to reduce the risk of nuclear war between the United States and Russia (Hot-line agreement, accidents measures, prevention of nuclear war)
C. The partial test ban treaty
D. Salt I
E. Civil Defense
F. Survival skills (C. H. Kearny)

7. List of Required Readings

Hiroshima by John Hersey, Bantam Books, 1946.

Commonsense in Nuclear Energy by F. Hoyle and G. Hoyle, W. H. Freeman and Co., 1980.

Nuclear Madness by Helen Caldicott, Bantam Books, 1980.

Energy One by J. R. Shanebrook (notes).

The Curve of Binding Energy by John McPhee, Ballantine Books, 1974.

The Counterforce Syndrome: A Guide to U. S. Nuclear Weapons and Strategic Doctrine by Robert C. Aldridge, Institute for Policy Studies, 1978.

"To Breed, or Not to Breed?" by Alvin M. Weinberg, Across the Board, The Conference Board Magazine, Vol. 14, Sept. 1977, pp. 5-24.

"How Israel Got the Bomb," by J. J. Fialka, The Washington Monthly, Vol. 10, Jan. 1979, pp. 50-58.

The Plumbat Affair by E. Davenport et al, J. B. Lippincott Co., 1978 (selected pages).

8. Information on the Films and Video-Tape Shown in this Course

"The Day After Trinity: J. Robert Oppenheimer and the Atomic Bomb". Available from Michigan Media, 416 Fourth St., Ann Arbor, MI 48109.

"Hiroshima and Nagasaki: The Harvest of Nuclear War". Available from Wilmington College Peace Resource Center, Pyle Center, Box 1183, Wilmington, OH 45177.

"The Medical Implications of Nuclear Energy" with Helen Caldicott. Available from Safe Energy Education, P.O. Box 1632, Ojai, CA 93023.

"No Act of God". This film explores the question of nuclear power and breeder reactors. Available from Bullfrog Films Inc., Oley, PA 19547.

"Countdown for America". This film discusses the campaign for a nuclear weapons freeze as contrasted with the campaign for a national strategy of peace through strength. Available from the American Security Council Foundation, Boston, Virginia 22713.

"Nuclear War: The Incurable Disease". This video-tape records the June 24, 1982 meeting in Moscow of three American doctors with three Soviet medical officials to discuss the medical effects of nuclear war. The tape was later shown twice on Soviet National Television to more than 200 million viewers. Available from International Physicians for the Prevention of Nuclear War, Inc., 225 Longwood Ave., Boston, MA 02115.